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October 28, 1991

Dr. Donald K. Wagner, Scientific Officer
Mathematical Sciences Division
Office of the Chief of Naval Research
800 N. Quincy Street
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RE: Contract #N00014-88-K-0104

Dear Dr. Wagner:

Our research administration office received a request for a final report on our project, *The Development of Modularized Software for Empirical Testing of New Algorithms in Linear Programming.* The project was originally for a three year period from Oct. 1, 1987-September 30, 1990. Although from a scientific point of view, our work was mostly concluded a year ago, we requested and received a one-year no cost extension to permit us to complete publications, travel to professional meetings and make presentations of our research results. An updated list of technical reports, publications and presentations is enclosed. This constitutes our final report.

A summary of the work accomplished follows.

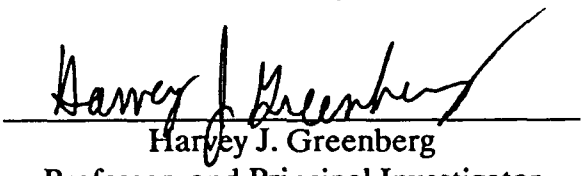
Empirical research into new strategies and tactics for linear programming requires realistic, large-scale problem-solving tools. The Workbench for Research In (linear) Programming, called WRIP, is a highly modularized system for generating, solving and analyzing instances of linear programs. The core of WRIP is OB1, an advanced optimizer that includes simplex and interior point methods. To support basic operations, OB1 contains a linear algebra library and related routines to process large, sparse matrices. Its modular structure enables algorithm experimentation by modifying one or more of its subroutines. In order to test ideas and gain insight into

an algorithm's performance, WRIP includes a modeling language, called MODLER, and a controlled randomization module, called RANDMOD. These enable meaningful randomization on raw data elements and matrix operations, respectively, that preserve the realism of the structure of the linear programming model while applying statistical inference. In addition, an interactive analysis system, called ANALYZE, is included to gain insights into problem and solution properties for deeper analysis of results. All modules are written in Fortran/77 and have been tested in a variety of computing environments.

WRIP has been distributed to about 30 academics engaged in mathematical programming research, in the U.S. and Europe. In addition, the principal investigators have extended their own insights into algorithm design through experimental rigor made possible by this software.

Please let me know if more information is required.

Sincerely,



Harvey J. Greenberg
Professor, and Principal Investigator

HJG/tmc

Encl. Report documentation page
List of publications, technical reports and presentations
Distribution list for WRIP
ANALYZE primer + disk
MODLER primer + disk
RANDMOD primer + disk

cc: Vickie Spencer, CU-Denver Research Administration
Roy Marsten, Co-PI, Georgia Tech

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13. ABSTRACT *(Maximum 200 words)*

Empirical research into new strategies and tactics for linear programming requires realistic, large-scale problem-solving tools. The Workbench for Research In (linear) Programming, called WRIP, is a highly modularized system for generating, solving and analyzing instances of linear programs. The core of WRIP is OB1, an advanced optimizer that includes simplex and interior point methods. To support basic operations, OB1 contains a linear algebra library and related routines to process large, sparse matrices. Its modular structure enables algorithm experimentation by modifying one or more of its subroutines. In order to test ideas and gain insight into an algorithm's performance, WRIP includes a modeling language, called MODLER, and a controlled randomization module, called RANDMOD. These enable meaningful randomization on raw data elements and matrix operations, respectively, that preserve the realism of the structure of the linear programming model while applying statistical inference. In addition, an interactive analysis system, called ANALYZE, is included to gain insights into problem and solution properties for deeper analysis of results. All modules are written in FORTRAN/77 and have been tested in a variety of computing environments.

WRIP has been distributed to about 30 academics engaged in mathematical programming research, in the U.S. and Europe. In addition, the principal investigators have extended their own insights into algorithm design through experimental rigor made possible by this software.

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linear programming, computational experimentation, interior point methods, sparse linear algebra

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Publications and Technical Reports:

E. Gelman, and J. Mandel, 1989. On Multilevel Iterative Methods for Optimization Problems, *Mathematical Programming Studies*, 48:1, 1-18.

R. E. Marsten, 1989. User's Manual for: OB1/XMP, Interior Point Methods for Linear Programming.

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